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YELLOW OXIDE OF MERCURY TREATMENT FOR SEED POTATOES ON LONG ISLAND

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ABSTRACT

WORKING with Irish Cobbler and Green Mountain potatoes under Long Island conditions, both whole tubers and seed pieces were treated with yellow oxide of mercury to prevent seed piece decay and rhizoctonia.

Emergence was definitely delayed by the treatment. The ultimate growth of Irish Cobbler plants was not affected, but Green Mountain plants tended to be smaller.

Stem infection by rhizoctonia was decreased.

During the period and under the conditions of the experiment, treating uncut Irish Cobbler tubers resulted in significant increases in yield. Yields of Green Mountain potatoes were not significantly increased and in certain seasons the yield was decreased.

In general, treating seed pieces resulted in decreased yields.

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YELLOW OXIDE OF MERCURY TREATMENT FOR SEED POTATOES ON LONG ISLAND

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Treating seed potatoes is a common practice in many potato growing sections and is generally accepted as being well worth while for the prevention of seed piece decay, for the control of both common scab and rhizoctonia, and as an aid in obtaining increased yields.

This practice, however, has never been universally adopted by Long Island potato growers. The older methods of treatment in use elsewhere are considered too laborious and too slow, and there is not sufficient evidence of increased yields to justify their use.

The introduction of organic mercury compounds as materials for use in treating seed potatoes created some interest among Long Island growers and resulted in work being done by Clayton.[2] He worked with both Irish Cobblers and Green Mountains, comparing mercuric chloride with organic mercury compounds. He found the organic mercury compounds to be inferior to mercuric chloride for the control of common scab and rhizoctonia but more effective in the prevention of seed piece decay. Treatment with organic mercury compounds resulted in slightly increased yields, but he concluded that seed treatment was not profitable for the Long Island grower.

There is, however, a considerable loss each year directly traceable to seed piece decay and rhizoctonia. Every year growers inquire concerning the possibility of seed treatment as a means of securing better stands and the demand is always for a method involving the least possible expenditure of time and labor. In an effort to meet this demand the work reported in this bulletin was undertaken.

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[1]The author is indebted to Dr. John D. Hartman for aid in the statistical analysis.

[2]Clayton, E. E. Potato seed treatment experiments on Long Island with special reference to the organic mercury instant dips. *New York State Agr. Exp. Sta. Bul. No. 564. 1929.*

METHODS

The experiment with yellow oxide of mercury as a material for treating seed potatoes was carried on for a period of 4 years. Both Irish Cobblers and Green Mountains were used in these tests.

In 1932 daily treatments of both whole tubers and seed pieces were made for a period of 13 days prior to planting. The following year this procedure was changed to provide for five treatments at weekly intervals. In this way the period elapsing between the first treatment and the time of planting was doubled.

Yellow oxide of mercury was used in 1932 at the rate of 1 pound to 12 gallons of water. It was thought that this mixture was too strong, and accordingly the following year the strength of the mixture was changed to 1 pound to 15 gallons of water. This strength was used for the remaining period of the experiment.

In 1932 each plat contained 20 hills placed 12 inches apart and planted in a single row. The plats were replicated five times. In the area devoted to the treatment of whole tubers the check plats were scattered thru each group of replicates. In the area devoted to the treatment of seed pieces each treated plat had a corresponding adjacent check. The following years each plat consisted of 78 hills planted in two rows. These plats were replicated four times. Arrangement of the check plats was the same as in 1932.

Since the first year's experiment differed from those of the succeeding years in the strength of the mixture used and the number of replicates and consisted of daily rather than weekly treatments, the results are not comparable and must be dealt with separately.

The yellow oxide was prepared for use by mixing it with cold water. This material is not soluble in water but merely forms a suspension which settles out rapidly on being allowed to stand, thus making it necessary to keep the mixture well stirred while seed is being treated. In making treatments the mixture was thoroly stirred just before each lot was dipped. The potatoes were placed in wire baskets and then dipped in the mixture, care being taken that all potatoes were covered. Each basket was moved quickly up and down three or four times to remove air pockets and insure thoro wetting of the tubers. The baskets were then removed and allowed to drain, after which the tubers were placed either in peach baskets or sacks and stored until time of cutting or planting.

Ordinary cultivation and spraying practices were applied thruout the season.

Four emergence counts were made at weekly intervals, the first being taken as soon as the plants began to show above ground.

The height of all plants was measured at the time the blossom buds appeared.

The potatoes were lifted with a digger. The tubers from each plat were run over a hand grader having a 1⅞-inch mesh. The yield results are based on the weight of marketable tubers by grade.

EFFECT ON SEED PIECES IN STORAGE

After they had been treated, no difficulty was experienced in keeping either whole tubers or seed pieces in storage. Seed pieces treated immediately after cutting gradually turned black on the cut surface. Microscopic examinations of sections from these cut surfaces revealed that only the outer two or three layers of cells were affected and that normal healing had taken place below these layers of darkened cells. If seed pieces cut from treated tubers are held in storage for any length of time, the same darkening of the cut surface occurs but to a lesser degree.

EFFECT ON EMERGENCE

In the case of seed piece treatment 2 years' results showing the effect on emergence are available and 3 years' results in the case of whole tuber treatment.

In 1933 all of the potatoes were planted on March 31 and the first emergence count made on May 12. The following year the Irish Cobblers were planted on April 5 and the Green Mountains the following day. Emergence counts began on May 14. In 1935 both varieties were planted on April 4 and the first count taken on May 15.

Tables 1 to 3 give the percentage emergence on the first count. When the second count was taken 1 week later, there was very little difference in the percentage emergence between treated and untreated seed.

When whole tubers were treated, yellow oxide of mercury used at the rate of 1 pound to 15 gallons of water had a very pronounced effect in delaying emergence. The length of time elapsing between the time of treatment and time of planting did not materially affect the results. In one case only did treated seed show as high a percentage emergence on the first count as did untreated seed and that was with Irish Cob-

TABLE 1.—PERCENTAGE EMERGENCE, 1933–35, WHOLE TUBERS TREATED.

YEAR	NOT TREATED	TREATED, NUMBER DAYS BEFORE PLANTING				
		1	8	15	22	29
		Irish Cobblers				
1933....	76	47	50	57	67	73
1934....	34	34	40	39	41	32
1935....	78	68	76	73	80	90
		Green Mountains				
1933....	66	37	48	56	47	54
1934....	69	23	29	24	21	23
1935....	43	29	33	34	19	10

blers in 1934. Thruout the period of the experiment this delay in emergence of treated seed has been more pronounced with Green Mountain than with Irish Cobbler potatoes.

When seed pieces were treated either at the time of planting or immediately after cutting, the delay in emergence was even more pronounced than when whole tubers were treated. Here again, the length of time between treating and planting seemed to bear no particular relation to the percentage emergence.

In 1933 the percentage emergence in Irish Cobblers was progressively lower when the tubers were cut more than 8 days before planting. When the seed pieces were treated at the time of planting, the earlier cuttings showed a decidedly lower percentage emergence on the first count than did the later cuttings (Table 2). The ultimate stand from the first cutting, made 29 days before planting, was 11 per cent where the seed was not treated and 4 per cent where the seed was treated. When the seed pieces were treated at the time of cutting, the condition was reversed on the first count (Table 3) and the ultimate stand was 89 per cent where the seed was treated and only 11 per cent where the seed was not treated.

This particular lot of Irish Cobblers came from North Dakota and the tubers were severely infested with rhizoctonia. It is doubtful if the rhizoctonia could be held responsible where the seed was cut some time prior to planting, for wherever the seed was cut shortly before planting the percentage emergence of untreated seed was normal at the time the first count was taken and the subsequent stand was perfect.

The seed pieces were stored under the same conditions each year and yet this trouble was only experienced with the one lot of seed. At plant-

TABLE 2.—PERCENTAGE EMERGENCE, 1933–34, SEED PIECES TREATED WHEN PLANTED.

YEAR	NUMBER DAYS CUT BEFORE PLANTING									
	1		8		15		22		29	
	Treated	Check	Treated	Check	Treated	Check	Treated	Check	Treated	Check
					Irish Cobblers					
1933....	57	81	43	66	11	28	4	10	1	2
1934....	25	53	37	45	27	46	27	54	35	54
					Green Mountains					
1933....	43	54	36	56	25	43	21	26	15	30
1934....	16	43	22	43	18	41	30	54	25	55

TABLE 3.—PERCENTAGE EMERGENCE, 1933–34, SEED PIECES TREATED WHEN CUT.

YEAR	NUMBER DAYS CUT BEFORE PLANTING									
	1		8		15		22		29	
	Treated	Check	Treated	Check	Treated	Check	Treated	Check	Treated	Check
					Irish Cobblers					
1933....	44	81	37	71	22	36	15	17	16	3
1934....	28	59	28	44	23	46	35	47	29	47
					Green Mountains					
1933....	27	55	40	64	25	43	15	36	15	23
1934....	26	48	39	45	38	61	31	56	34	66

ing time all seed pieces were well healed over and no evidence of rotting was found.

Wherever misses occurred, the seed pieces were dug up and examined. In all cases they were found to be decayed. The longer the period of time elapsing between cutting and planting, the larger was the number of decayed seed pieces found.

EFFECT ON SEED PIECE DECAY

With the exception of the instance mentioned under the previous heading, seed piece decay was not experienced on any of the plats during the period of the experiment. In the case of Irish Cobblers in 1933, where the seed pieces were cut 4 weeks before planting and treated immediately after cutting, the treated seed gave an ultimate stand of 89 per cent, while the untreated seed gave only 11 per cent. In this particular case it is evident that seed treatment had a marked effect in preventing decay.

EFFECT ON RHIZOCTONIA

Potato tubers grown on Long Island are not ordinarily affected with rhizoctonia. In an occasional season some sclerotia may be found on the tubers, but these are usually very small and not at all conspicuous. In the 4 years this experiment was carried on the tubers grown on these plats were free from rhizoctonia.

Stem lesions are common and in certain soils and in certain seasons the emergence may be delayed or the stand adversely affected due to rhizoctonia. It is generally thought that such injury is more likely to occur if the potatoes used for seed purposes are infested with rhizoctonia. However that may be, severe injury frequently does occur solely as a result of soil infection.

During the seasons of 1933–35 the plants in one row in each plat were pulled at blossoming time and the stems examined for rhizoctonia lesions. No attempt was made to classify the degree of injury, but all of the plants affected were found to have conspicuous lesions on the stems. The stems were not entirely girdled but in most cases the lesion involved at least one-half of the stem circumference. The results of these counts are given in Table 4.

The seed used in these experiments was all certified stock such as is being used generally by Long Island growers. With the exception of the Irish Cobblers used in 1933, all of the seed was free from rhizoc-

TABLE 4.—PERCENTAGE PLANTS AFFECTED WITH STEM LESIONS CAUSED BY RHIZOCTONIA WHERE WHOLE TUBERS WERE TREATED.

YEAR	NOT TREATED	TREATED, NUMBER DAYS BEFORE PLANTING				
		1	8	15	22	29
			Irish Cobblers			
1933....	39	23	24	28	24	25
1934....	45	29	31	20	13	23
1935....	36	4	7	12	8	6
			Green Mountains			
1933....	73	68	53	58	65	58
1934....	51	15	24	15	18	17
1935....	49	34	40	38	43	34

tonia. Stem infection in this case may have been due to the seed, but in all other cases the stem lesions found in the plats were due to soil infection.

The figures given in Table 4 show that in this experiment treating seed with yellow oxide of mercury at the strength used had the effect of reducing the percentage of stems affected with rhizoctonia even if the organism was soil borne. Another interesting fact is that in 1933, when the Irish Cobbler seed was heavily infested with rhizoctonia and the Green Mountain seed was clean, the percentage of stems bearing rhizoctonia lesions was higher in the Green Mountain potatoes than in the Irish Cobblers. Thus it would seem that the danger of stem infection from the soil may be even greater than from infected seed.

EFFECT ON GROWTH

Since emergence was definitely delayed by treatment, it was decided to measure the height of all plants to see what effect this delayed emergence might have upon ultimate growth. The plants were measured at the time the blossom buds appeared. At this time there was no visible difference in their height (Table 5).

Delayed emergence apparently did not seriously affect the ultimate growth of Irish Cobbler plants from treated seed, as is shown by the average height of plants given in Table 5.

In 1933 and 1934 Green Mountain plants from treated seed averaged approximately 1 inch less in height than did plants from untreated seed. In 1935 this condition was reversed.

TABLE 5.—AVERAGE HEIGHT OF PLANTS IN INCHES AT THE TIME THE BLOSSOM BUDS APPEARED WHERE WHOLE TUBERS WERE TREATED.

YEAR	NOT TREATED	TREATED, NUMBER DAYS BEFORE PLANTING				
		1	8	15	22	29
			Irish Cobblers			
1933....	10.9	10.1	10.9	10.5	10.3	11.2
1934....	10.2	9.5	10.1	10.1	10.4	9.5
1935....	13.9	13.9	13.7	13.8	13.7	14.1
			Green Mountains			
1933....	10.9	9.1	9.6	9.2	9.5	9.9
1934....	10.2	9.2	9.7	9.2	9.1	9.7
1935....	13.5	14.6	14.8	14.5	14.5	14.3

EFFECT ON YIELD

The effect on yield is presented in Tables 6 to 9. The figures given for treated seed represent the increase or decrease over the corresponding untreated lots. These figures show a wide variation which is not correlated with the time at which the treatment was applied.

The 1932 figures are an average of five replications, while the 1933–35 figures are an average of four replications. The last row of figures in Table 7 under each variety represents the average for the 5-year period. In those sections of the tables dealing with the treatment of whole tubers, the average yield in bushels per acre is given for untreated seed. This is done to give some idea of the relative yields. Similar figures are not given in the sections dealing with the treatment of seed pieces because of the large number of untreated plats involved where adjacent checks are used.

The figures have been treated statistically by Fisher's[3] method of analysis of variance. The figures for significance according to this method are given in the tables.

THE 1932 RESULTS

The 1932 results are given in Table 6. For reasons already mentioned these results are not comparable with the results of the following years.

With Irish Cobblers when whole tubers were treated, 8 out of the 13 treatments gave a slight increase in yield over untreated seed, while the remainder showed a loss. None of these differences were signifi-

[3]Fisher, R. A., and Wishart, J. The arrangement of field experiments and the statistical reduction of the results. *Imp. Bur. Soil Sci. Tech. Com. No. 10. 1930.*

TABLE 6.—AVERAGE DIFFERENCE IN YIELD BETWEEN TREATED AND UNTREATED SEED IN BUSHELS OF MARKETABLE TUBERS PER ACRE, 1932.

VARIETY	NOT TREATED	TREATED, NUMBER DAYS BEFORE PLANTING													FIGURE FOR SIGNIFICANCE
		1	2	3	4	5	6	7	8	9	10	11	12	13	
Whole Tubers Treated															
Irish Cobbler	257.08	9.56	8.40	15.82	6.08	—32.68	0.44	1.44	15.02	6.24	—0.36	12.38	—7.94	24.78	35.61
Green Mountain	244.48	27.72	21.16	41.56	18.36	22.16	49.22	34.02	16.06	18.36	24.14	2.34	16.56	12.24	34.35
Seed Pieces Treated When Planted															
Irish Cobbler	——	—9.68	6.90	6.96	15.66	13.70	2.46	4.46	4.94	—9.40	—10.72	16.20	47.60	—6.18	35.86
Green Mountain	——	1.34	5.58	—5.94	25.05	16.82	—35.82	—6.92	9.28	—24.06	14.72	54.78	24.38	0.78	41.49
Seed Pieces Treated When Cut															
Irish Cobbler	——	4.92	14.34	2.05	—2.46	16.20	6.46	9.92	23.10	12.38	27.74	4.96	19.68	6.44	35.72
Green Mountain	——	18.16	—13.34	2.82	22.60	24.06	10.26	—7.92	11.90	4.96	30.32	—5.94	—5.78	45.10	49.61

cant. Where the seed pieces were cut on different dates before planting and treated at planting time, 8 out of 13 treatments resulted in increased yields over untreated seed and one of these increases was significant. When seed pieces were cut at different times before planting and treated immediately after cutting, all but one of the treatments yielded higher than the untreated seed, but none of the figures were significant.

With Green Mountains when whole tubers were treated, increased yields were shown for all treatments and in two cases these increases were significant. Treatment of seed pieces at planting time resulted in increased yields in eight of the treatments and losses for the remainder with only one figure significant. When seed pieces were treated immediately after cutting, nine of the treatments showed increased yields and four showed losses. None of the differences were significant.

THE 1933–35 RESULTS

The 1933–35 results for the treatment of whole tubers are given in Table 7.

TABLE 7.—AVERAGE DIFFERENCE IN YIELD BETWEEN TREATED AND UNTREATED SEED IN BUSHELS OF MARKETABLE TUBERS PER ACRE WHERE WHOLE TUBERS WERE TREATED.

YEAR	NOT TREATED	TREATED, NUMBER DAYS BEFORE PLANTING					FIGURE FOR SIGNIFICANCE
		1	8	15	22	29	
				Irish Cobblers			
1933....	285.15	78.69	62.61	35.54	68.54	61.77	54.18
1934....	231.25	48.02	63.89	90.55	84.83	63.05	32.26
1935....	220.74	32.98	42.98	42.28	53.28	55.82	45.22
1933–35	239.71	53.23	56.83	56.12	68.88	60.21	26.51
				Green Mountains			
1933....	323.22	—19.74	50.21	49.93	60.08	47.39	54.46
1934....	276.93	—22.32	—13.96	—28.14	—21.16	—12.06	20.58
1935....	197.90	21.99	29.18	9.73	41.02	9.31	35.28
1933–35	266.01	—6.69	21.81	10.51	26.65	14.88	31.86

With Irish Cobblers all of the treatments resulted in substantial increases in yield thruout the 3-year period. With the exception of three figures in 1935, all were highly significant. An average of the 3-year period shows increased yields for all treatments and these increases are more than twice that of the figure required for significance.

The results with Green Mountains were not so clear cut. In 1933, four out of the five treatments gave a substantial increase in yield with one treatment showing a loss. Three of the increases were significant.

In 1934 there was a decreased yield from all treatments, three being significant. The 1935 results were favorable for all treatments but not significantly so. The average of the 3-year period shows increased yields for four of the treatments while one shows a loss. None of the figures were significant.

Tables 8 and 9 give the results of the work with seed piece treatment for the years 1933–34.

TABLE 8.—AVERAGE DIFFERENCE IN YIELD BETWEEN TREATED AND UNTREATED SEED IN BUSHELS OF MARKETABLE TUBERS PER ACRE WHEN SEED PIECES WERE TREATED WHEN PLANTED.

YEAR	TREATED, NUMBER DAYS CUT BEFORE PLANTING					FIGURE FOR SIGNIFICANCE
	1	8	15	22	29	
			Irish Cobblers			
1933	8.46	57.53	—16.07	55.84	—27.92	48.16
1934	—19.67	6.76	—6.34	—4.77	5.92	26.18
			Green Mountains			
1933	0.84	—27.92	—5.08	7.61	11.85	61.32
1934	—26.32	—24.96	—30.46	—19.25	—25.59	33.04

TABLE 9.—AVERAGE DIFFERENCE IN YIELD BETWEEN TREATED AND UNTREATED SEED IN BUSHELS OF MARKETABLE TUBERS PER ACRE WHEN SEED PIECES WERE TREATED WHEN CUT.

YEAR	TREATED, NUMBER DAYS CUT BEFORE PLANTING					FIGURE FOR SIGNIFICANCE
	1	8	15	22	29	
			Irish Cobblers			
1933	—38.92	24.53	46.53	125.22	208.99	115.36
1934	—29.36	—27.73	—9.73	—13.32	—15.02	33.04
			Green Mountains			
1933	5.41	—6.76	—5.92	—5.64	—34.68	42.70
1934	—45.70	13.11	—37.23	—8.46	—21.15	58.00

With Irish Cobblers where the seed pieces were cut at various intervals before planting and treated at planting time, three out of five treatments in 1933 gave increased yields, two of these increases being significant. In 1934 only two treatments showed increased yields and neither of these was significant.

In 1933 treating Irish Cobbler seed pieces immediately after cutting resulted in increased yields in four out of five of the treatments. Two of these increases were significant. These increases were due to preven-

tion of seed piece decay as a result of the treatment as discussed on page 8. In 1934 losses were recorded for all treatments, but they were not significant.

With Green Mountains, both where the seed pieces were treated at planting time and where they were treated immediately after cutting, the results showed, in general, a lower yield due to treatment, but in no cases were the figures significant.

CONCLUSIONS

When seed potatoes were treated with yellow oxide of mercury at the rate of 1 pound to 15 gallons of water, the emergence was definitely delayed. This delayed emergence did not affect the ultimate growth of Irish Cobbler plants, but it did affect the growth of Green Mountain potatoes.

Seed pieces cut from treated seed became blackened on the cut surface if held in storage for any length of time, but this discoloration did not prevent proper healing of the cut surface.

Stem infection from rhizoctonia was reduced even if the organism was soil borne.

During the period and under the conditions of this experiment, treating uncut Irish Cobbler tubers resulted in significant increases in yield over untreated seed.

Treating uncut Green Mountain tubers did not increase the yields significantly and in certain seasons resulted in lower yields.

Treating seed pieces either at the time of cutting or at the time of planting is likely to result in decreased yields.

The treatment may be applied at least 4 weeks previous to planting without injurious effects.